Motivation

One of the big challenges in Numerical Weather Prediction is to reduce the uncertainty in the initial conditions. At the National Meteorological Service (SMN) of Argentina, many efforts have been carried out to address this issue.

Methodology

The application of the WRF-LETKF [Weather and Research Forecasting Model - Local Ensemble Transform Kalman Filter] Data Assimilation System during a test period. (Hunt et al, 2007; Miyoshi and Xue, 2011; Miyoshi and Xue, 2012)

Common configuration

WRF-LETKF System developed at the University of Maryland.

5 h assimilation windows
5 h analyses frequency
Test period: 02 Nov – 31 Dec 2012
40 Ensemble Members

Spatial localization: Horizontal ~ 1400 km
Vertical: 0.4 (log scale) (~ 4 km aprox)

Initial Conditions (IC): 01 Nov 00 UTC. GFS deterministic analysis was perturbed using differences between consecutive atmospheric states (Eq. 1). To generate the 40 perturbations, analyses of Oct and Nov 2010 were used.

WRF parameters: Kain-Fritsch (cumulus); WSM4 (microphysics); YSU (planetary boundary layer); MM5 similarity (surface layer); RRTM (OIR radiation); Dudhia (SVR radiation); Noah LSM.

Boundary Conditions (BC): 3 hourly GFS deterministic forecasts (0.5°)

Assimilated observations: from NCEP-PRERBUFR files (Hopper 2012), including surface stations (ADPSFC), radiosondes (ADPINF); aircrafts (ADPIFT), ships (SHP), GOES Atmospheric Motion Vectors (SATEM). Also surface wind estimates by ASCAT with a Super-Gliding (SG) technique applied.

E-CONTROL

Is the Control run, with all the specifications indicated on the left box.

E-MULTI

A multi-scheme configuration is used in order to better represent the ensemble spread. Cumulus and PBL parameterizations are combined:

E-BPRT

The same configuration of E-CONTROL but including perturbed B.C., which are generated with a similar technique of that applied to IC, using consecutive dates for each ensemble members.

E-AIRS

The same configuration of E-CONTROL assimilating also the vertical profiles of temperature and humidity from AIRS, using a thinning technique.

Results

Bias for 6h forecasts [ref: ERA-I]

Root mean square difference of energy, 6h forecasts [ref: ERA-I]

E-AIRS shows a reduction of Bias and energy errors with respect to E-CONTROL

E-AIRS outperforms E-CONTROL for the whole vertical

Bias for 12, 24, 36 and 48h forecasts initialized at 12 UTC [ref: ERA-I]

Depending on the vertical level and the forecast time, different experiments show the minor bias

Performance of the ensemble system

Scatter plots for the zonal component

The spread of the ensemble of analyses is not effective enough to represent the error of the mean analysis (considering as ref. ERA-I). This issue needs more insight in the future in order to obtain a better performance of the system.

References:


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Concluding remarks

- Inclusion of AIRS retrievals is a valuable alternative to deal with the scarcity of radiosondes observations in Southern South America.
- Multi scheme ensemble configuration had a positive impact in the forecasts too.
- Experiment with perturbed boundary conditions showed a low skill, probably due to the theoretical method used which did not account for the errors of the day.
- Future work would focus on the implementation of different inflation parameters, which is a characteristic but non-trivial feature of the LETKF, and the evaluation of other strategies of perturbing lateral boundary conditions.